

VASCULAR FLORA OF BEAVER WETLANDS IN WESTERN MASSACHUSETTS

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ABSTRACT. The composition and structure of vegetation in beaver wetlands located in Franklin and Hampshire Counties of western Massachusetts were studied from 1980 to 1995. A flora of 231 vascular plants was recorded within fifteen selected field sites including seven new county records and one state-listed species (*Ophioglossum vulgatum* var. *pseudopodium*). Relatively few species (5.6% of the total flora) were introduced. Factors contributing to high vascular plant diversity included 1) steep hydrological gradients created by beaver dams; 2) spatial heterogeneity caused by beaver artifacts, human structures and geological features; and 3) temporal heterogeneity resulting from beaver activity and hydrological fluctuations. While beaver activity has helped maintain regional vascular plant diversity in western Massachusetts since the reestablishment of beaver populations in the 1920s, current increases in beaver densities may pose a threat to later successional wetland species.

Key Words: beaver (*Castor canadensis*), vascular flora, wetlands, Massachusetts

The beaver (*Castor canadensis*) has had a profound impact on the landscape of western Massachusetts. Trapped to regional extinction in the mid-18th century, it returned in 1924 when a colony immigrated into West Stockbridge (Berkshire County). Augmented by reintroductions by the Massachusetts Department of Conservation, the state-wide population expanded rapidly, totaling approximately 52,000 in 1999 (S. Langlois, pers. comm.).

Beavers alter the structure and composition of both upland and riparian vegetation. They forage on woody vegetation 60 m or more from a stream course, girdling and felling trees, shrubs, and vines (Hall 1960; Rutherford 1955) and utilizing over 90 woody food species throughout their range (McMaster 1989).

Beaver dams in Massachusetts are constructed of branches, vines, shrubs, herbaceous plant material, boulders, sand, gravel, and mud. They range from 0.3 to 2 m in height and 3 to 300 m in length (Shaw 1948). Often placed against stone walls or culverts, they span stream channels and extend to the edges of the adjacent uplands.

New dams create impoundments up to 8 ha in area extending upstream and into the uplands along the stream margins. Above dams, soils are saturated, stream velocity is reduced, and sediment accumulates. Below dams, discharge rates decline and sediment loads are reduced (Naiman et al. 1988). These hydrological alterations in turn influence stream biogeochemistry including carbon cycling (Naiman et al. 1986), methane evasion rate (Ford and Naiman 1988), soil redox potential (Naiman et al. 1988), pH and acid-neutralizing capacity (Smith et al. 1991), and biological oxygen demand and dissolved oxygen concentration (Naiman et al. 1988).

Following inundation, most woody vegetation is killed within one or two growing seasons. Within five years shallower areas, particularly along the pond margins or adjacent to the dams or lodges, are colonized by floating-leaved and submerged aquatics and emergent hydrophytic plants.

When beaver colonies are removed by trapping or predation or when they migrate to another site as food supply dwindles, unmaintained dams deteriorate and sites gradually drain. The upstream end of a site and the lateral margins usually drain first while the areas immediately above the dam and surrounding the lodge are often among the last to drain. Eventually the stream cuts a channel in the bottom sediments before exiting through one or more openings in the abandoned dam.

An unmaintained beaver dam may impound water during spring meltout and after periods of heavy precipitation, thus affecting site hydrology for years, sometimes decades, after abandonment. Factors that influence the frequency, extent, and duration of reflooding include the condition of the old dam, the topographical gradient of the site, and the size of the watershed upstream of the site (McMaster 1997).

The goals of the study initiated by Nancy D. [Mosher] McMaster in 1980 were to describe the composition and structure of the vascular vegetation in beaver-impacted wetlands, to analyze vegetational changes over the duration of the study, and to develop a model for succession in beaver-impacted wetlands. She initially sampled all vascular vegetation in fifteen sites over the period from 1980 to 1984 and began resampling in 1985, a process that continued until her death in 1990 (McMaster 1989). In 1991 Robert T. McMaster resumed the sampling schedule, em-

ploying the transects and methodology of the previous work (McMaster 1997).

This paper presents a combined list of vascular plant species found in all fifteen sites over the period 1980–1995 from both studies, as well as abundance data, descriptions of plant communities, county and state records, and changes in species diversity. A more detailed analysis of the structure and dynamics of vascular vegetation over the fifteen-year interval will be presented in a forthcoming paper.

MATERIALS AND METHODS

Eighty sites in Franklin and Hampshire Counties were initially identified from topographic maps and aerial photographs as likely beaver-impacted wetlands. After field reconnaissance, sites currently occupied by beavers and sites subject to human disturbance such as burning, logging, and excavation were eliminated. The fifteen sites thus selected (Figure 1; Table 1) ranged in area from 0.6 to 8.0 ha and in elevation from 164 to 465 m above sea level. All were located on the eastern slope of the Berkshire Plateau in an area of finely corrugated muscovite schist interbedded with layers of gneiss and white quartzite (McMaster 1989). Soils were a combination of glacial tills, alluvium, and muck (Egler 1940). Five sites were adjacent to paved roads, six to unpaved roads, and four were accessible only by footpath.

Site histories were reconstructed by examination of USDA Soil Conservation Service maps and panchromatic black and white aerial photographs (scale 1:24,000), US Geological Survey maps, deeds, town histories, by communication with property owners, and by field observation. Sites were monitored regularly for presence or absence of active beaver colonies throughout the period of the study. Site age (i.e. number of years since last beaver occupation of a site) was determined from communication with property owners or local residents for activity previous to 1980 and from direct observation in the field for sites occupied since 1980.

Vegetation was sampled along transects established across each site parallel to the remains of the beaver dam. Along each transect, 0.5 m $\times$ 0.5 m quadrats were located at 2 m intervals. Five categories were used to estimate abundance based on criteria de-

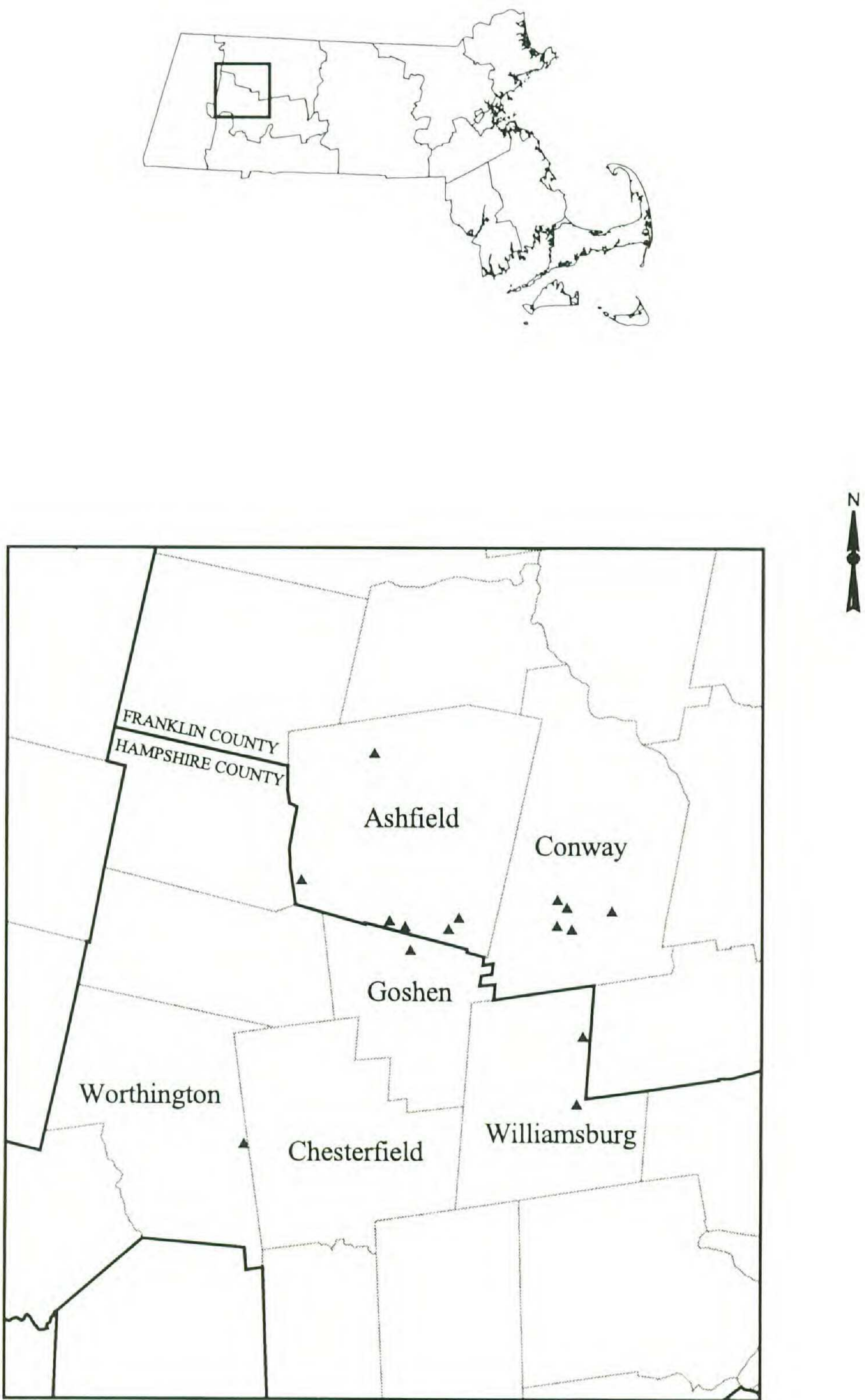


Figure 1. Location of field sites.

Table 1. County, watershed, elevation above sea level (m), area (ha), and age (years) since last beaver occupation (as of 1995) for the fifteen study sites. ¹Refers to the Mill River with headwaters in Conway, which enters the Connecticut River at Hatfield. ²Refers to the Mill River with headwaters in Goshen and Ashfield, which enters the Connecticut River at Easthampton.

Site	County	Watershed	Eleva- tion (m)	Area (ha)	Age (years)
Ashfield 1	Franklin	Westfield River	417	3.8	20
Ashfield 2	Franklin	Westfield River	417	1.4	40
Ashfield 3	Franklin	Westfield River	393	2.5	1
Ashfield 4	Franklin	Mill River ¹	453	6.2	1
Ashfield 5	Franklin	Mill River ¹	453	2.5	1
Ashfield 6	Franklin	Deerfield River	465	1.8	16
Conway 1	Franklin	Mill River ¹	369	1.8	25
Conway 2	Franklin	Mill River ¹	362	2.5	35
Conway 3	Franklin	Mill River ¹	338	3.2	18
Conway 4	Franklin	Mill River ¹	329	1.0	15
Conway 5	Franklin	Mill River ¹	243	3.5	16
Goshen 1	Hampshire	Mill River ²	417	2.1	18
Williamsburg 1	Hampshire	Mill River ¹	220	7.8	26
Williamsburg 2	Hampshire	Mill River ²	164	0.6	16
Worthington 1	Hampshire	Westfield River	375	8.0	10

scribed by Palmer et al. (1995): abundant, frequent, occasional, infrequent, and rare.

All sites were originally sampled in mid-summer between 1980 and 1984 (McMaster 1989; Mosher 1981). Three sites, Conway 1, 2, and 3, were resampled at five year intervals. The remaining twelve sites were to be resampled at ten year intervals when possible. Seven of these were resampled on schedule. Ashfield 3, which had been reoccupied by beavers in 1992, was resampled in 1993 after the site was once again abandoned. Four sites, Ashfield 6, Conway 5, Goshen 1, and Worthington 1, which were first sampled in 1984, could not be resampled in 1994 or subsequently due to continued beaver occupation but were revisited at regular intervals.

Percent species turnover for a site (T) was calculated as follows:

$$T = (E + R)/S \times 100$$

where,

E = Number of extinctions between samplings;

Table 2. Floristic summary of plant taxa in fifteen beaver-impacted wetlands, Franklin and Hampshire Counties, Massachusetts.

Group	Families	Genera	Native Species	Introduced Species	Total Species
Pteridophytes	7	8	12	0	12
Gymnosperms	2	3	3	0	3
Angiosperms					
Dicots	45	89	138	10	148
Monocots	14	32	65	3	68
TOTAL	68	132	218	13	231

R = Number of recruitments between samplings;

S = Total number of species present in both samplings of the site.

The species list presented includes all vascular plant taxa found in systematic sampling of the fifteen sites as well as in general reconnaissance of the sites from 1980 to 1995. Nomenclature for all species and identification of introduced species are based on Gleason and Cronquist (1991). State and county records are based on Magee and Ahles (1999) and lists obtained from the Massachusetts Natural Heritage and Endangered Species Program. Voucher specimens for all taxa are held in the Smith College Herbarium (SCH).

RESULTS

The flora of the 15 study sites included 231 vascular plant taxa in 68 families and 132 genera (Table 2; Appendix). The distribution of taxa by life-form was as follows: 108 forbs, 55 graminoids, 30 shrubs, 22 trees, 12 ferns and fern allies, and 4 vines. Plant families best represented in the flora were Cyperaceae (30 species), Asteraceae (19 species), Rosaceae (16 species), and Poaceae (15 species). All but four species were perennials. Two species are county records for Hampshire County and five are county records for Franklin County (Table 3). One species is currently listed as threatened in Massachusetts, *Ophioglossum vulgatum* var. *pseudopodium*, the northern adder's-tongue fern (Massachusetts Natural Heritage and Endangered Species Program 1997). The population in this study was the largest in the state with approximately 900 sporophytes counted in 1991 (McMaster

Table 3. County records among the flora of the fifteen study sites.

Species	Site
Hampshire County	
<i>Galium trifidum</i>	Williamsburg 1 and 2, Worthington 1
<i>Juncus conglomeratus</i>	Williamsburg 1
Franklin County	
<i>Carex eburnea</i>	Conway 5
<i>Carex lacustris</i>	Ashfield 3, 4, 5
<i>Juncus brachycephalus</i>	Conway 3, 4
<i>Oenothera fruticosa</i>	Conway 3
<i>Potentilla palustris</i>	Ashfield 2

1994, 1996). Currently, *O. vulgatum* var. *pseudopodium* is also state-listed in Connecticut (Connecticut Department of Environmental Protection 1995) and Rhode Island (Enser 1998).

Species richness per site ranged from 32 species in Conway 2 (1995) to 79 species in Conway 5 (1984). Number of families represented in each site ranged from 19 families in Conway 2 (1995) to 34 families in Conway 5. Over one-third (84) of the species occurred in only one site. Ten species occurred in all fifteen sites: *Acer rubrum*, *Carex stipata*, *Impatiens capensis*, *Leersia oryzoides*, *Ludwigia palustris*, *Onoclea sensibilis*, *Salix sericea*, *Scirpus cyperinus*, *Spiraea alba* var. *latifolia*, and *S. tomentosa* (Appendix).

Thirteen species or 5.6% of the total vascular flora were introduced species: *Achillea millefolium*, *Agrostis gigantea*, *Berberis thunbergii*, *Cirsium arvense*, *Conium maculatum*, *Echinochloa crusgalli*, *Hypericum perforatum*, *Juncus conglomeratus*, *Lonicera* × *bella*, *Myosotis scorpioides*, *Potentilla norvegica*, *Rorippa nasturtium-aquaticum*, and *Solanum dulcamara*. This compared to 20% for eastern and central North America according to Fernald (1950). Eight of the thirteen introduced species occurred in only one site. The most common introduced species was *Agrostis gigantea*, which occurred in nine of the fifteen sites. Surprisingly, the site with the most introduced species was Conway 3, the most remote of all the sites.

A typical beaver-impacted wetland may best be characterized as a complex mosaic of five physiographic zones, each with its own characteristic plant community. The precise arrangement of

the zones varied from site to site depending on geomorphology, beaver activity, and human disturbance.

Zone 1, open water. This zone included standing water above the dam and moving water in the stream channel that persisted throughout the growing season. Areas of deeper water were dominated by floating-leaved aquatics such as *Lemna minor* and *Utricularia vulgaris* or rooted hydrophytes such as *Brasenia schreberi*, *Najas flexilis*, *Nuphar variegata*, *Polygonum amphibium*, and *Potamogeton* spp. while shallower waters were colonized by emergents such as *Sparganium* spp., *Carex* spp., and *Scirpus* spp. The stream channel was often vegetated by *Potamogeton* spp. and *Ludwigia palustris*.

Zone 2, mud flats. Upstream of the open water, saturated bottom sediments were exposed through most of the growing season but were frequently reflooded for short periods. Mud flats were often dominated by stands of *Leersia oryzoides*, *Lysimachia terrestris*, or *Eleocharis acicularis*.

Zone 3, wet meadows. Farther upstream, the partially drained soils of wet meadows occasionally were reflooded during the growing season. They were most often dominated by species of *Carex*, *Scirpus*, *Juncus*, *Solidago*, and *Eupatorium* as well as by *Impatiens capensis*. In some sites tussock-forming graminoids such as *Calamagrostis canadensis*, *Carex stricta*, *Phalaris arundinacea*, and *Scirpus cyperinus* created a hummock-and-hollow microtopography (McMaster 1989).

Zone 4, drier meadows. Still farther upstream and adjacent to the site margins were drier meadows, areas of well-drained soils which rarely were reflooded during the growing season. Here emergent hydrophytic graminoids such as *Carex crinita*, *Eleocharis* spp., *Glyceria canadensis*, *Juncus effusus*, and *Typha latifolia* occurred in association with herbaceous species including *Aster puniceus*, *Eupatorium maculatum*, *Galium tinctorium*, and *Impatiens capensis*. In some sites *Typha latifolia* formed large pure stands in this zone.

Zone 5, dry meadows and upland margins. Along the wetland/upland boundaries of sites where reflooding seldom oc-

Table 4. First and last sampling years, species richness at first sampling, number of recruitments and extinctions, species richness at last sampling, net change in species richness, and percent species turnover for eleven study sites.

Site	Years Sampled	Species Rich- ness First	Re- cruit- ments	Extinc- tions	Species Rich- ness Last	Net Change	Species Turn- over
Ashfield 1	82–92	47	20	22	45	–2	63%
Ashfield 2	82–92	41	12	19	34	–7	58%
Ashfield 3	82–93	40	24	19	45	+5	67%
Ashfield 4	84–94	72	18	36	54	–18	60%
Ashfield 5	84–94	68	12	41	39	–29	66%
Conway 1	80–95	57	10	15	52	–5	37%
Conway 2	80–95	44	13	25	32	–12	67%
Conway 3	80–95	70	16	27	59	–11	50%
Conway 4	84–94	55	38	23	70	+15	66%
Williamsburg 1	84–94	49	19	23	45	–4	62%
Williamsburg 2	84–94	52	22	20	54	+2	57%

curred, the emergent hydrophytes and herbaceous species found in Zone 4 mixed with a variety of woody wetland species including *Spiraea alba* var. *latifolia*, *Ilex verticillata*, and *Alnus incana*. Also occasionally found in this zone were saplings of woody species common in the surrounding upland, especially *Acer rubrum*, *Betula alleghaniensis*, *B. lenta*, *B. papyrifera*, *B. populifolia*, and *Prunus serotina*.

Disturbed areas. Some areas of a site including beaver dams, lodges, and food caches; stone walls; roadway embankments; and outcrops of bedrock were above high water but were subject to frequent disturbance from beaver or human activity. Vegetation in these areas included woody upland species such as *Fagus grandifolia*, *Fraxinus americana*, *Pinus strobus*, and *Tsuga canadensis*, shrubby pasture species such as *Juniperus communis* and *Berberis thunbergii*, and herbaceous species including *Conium maculatum*, *Achillea millefolium*, and *Solanum dulcamara*.

Table 4 lists the number of vascular plant species occurring in sampled plots over ten-to-fifteen-year intervals between sampling in eleven sites (the other four sites were not resampled due to reoccupation). Recruitments exceeded extinctions (i.e. species richness increased) in three sites over the interval between sampling while extinctions exceeded recruitments in eight sites. All

but one of the eleven sites had a percent turnover of 50% or more. Mean percent turnover for the eleven sites was 67%.

DISCUSSION

Total vascular plant diversity of the fifteen field sites, 231 taxa, was relatively high considering the small area (48.7 ha) represented. In a study of the herb strata of three Connecticut River oxbows in western Massachusetts, Holland and Burk (1984) identified 130 taxa of herbs, vines, and woody seedlings over a single growing season in three sites totaling 64 ha. M. Hickler reported 177 vascular species in a three-year survey of fifteen oxbows of the Nashua River (Massachusetts) totaling 12.5 ha (pers. comm.). In a botanical survey of a 162 ha natural area in Franklin County, McMaster (1987) identified 532 vascular plant species in a single season.

High plant diversity in the study sites resulted from several factors. Spatial variability within a site may be attributed to the steep hydrologic gradient created by the dam and to the topographical heterogeneity created by beaver artifacts (dams, lodges, food caches, canals, etc.), human structures (walls, roadways, utility lines, etc.), and geological features (glacial erratics and outcrops of bedrock). Temporal variability within a site resulted from beaver activity (building of dams, lodges, and other artifacts; maintenance of beaver structures; eventual abandonment), human impacts (destruction of dams, trapping, filling, dredging, burning, grazing cattle), and hydrological effects (reflooding, draining, and drought). Invasion of dominant forest species that could shade out herbaceous species was controlled by the saturated soils over most of the area of a site. Finally, vascular plant diversity among the fifteen sites appeared to be enhanced by variations in soil and water chemistry (McMaster 1997).

The small number of introduced species may be attributed to two factors. Many of the non-native plants of eastern North America are associated with agriculture, adapted to dry, disturbed habitat such as fields or road edges, and are unlikely to germinate in the saturated soils found in beaver-impacted wetlands. Those able to germinate as soils drained in late spring or early summer may not have been able to reach maturity in the short period before reflooding occurred and conditions again became intolerable.

Two wetland plant species, *Lythrum salicaria* and *Phragmites australis*, are of particular concern in the northeastern United States due to their aggressiveness and ability to drive out native wetland species. Both are common in disturbed areas and appear to follow major transportation arteries. While *L. salicaria* is found in abundance in many wetlands of eastern and central New England, it has not yet appeared in any of the study sites. This may be due in part to elevation, climate, soil type, or to the relative remoteness of these sites from major highways. *Phragmites australis* was present in only one of the fifteen study sites where it occurred in a very limited area along an abandoned utility right-of-way.

Decline in species richness observed in eight sites was primarily among shrubs and trees, probably the result of repeated beaver occupation and reflooding during the 10–15 year interval (while all sites were inactive at the onset of the study, at least one reoccupation occurred in ten of the fifteen sites over the period of this study). Increase in species richness observed in the other three sites was due primarily to recruitment of woody species from the surrounding upland or from the seed bank as draining proceeded in the absence of reoccupation. Vascular plant diversity began to decline again in sites unoccupied for more than twenty years, however, probably due to the loss of herbaceous species unable to compete with invading shrubs and trees. Additional data on changes in species composition, zonation, and diversity in the fifteen sites over the duration of this study will be presented in a forthcoming paper.

Most of the vascular plant species found in beaver-impacted wetlands depend on the presence of saturated soils and full sun, a rare combination of conditions in New England in the absence of beaver activity. As beaver population density increases and available habitat declines, reoccupation of abandoned sites is likely to occur at shorter intervals. Under these conditions plant species such as *Ophioglossum vulgatum* var. *pseudopodium* that favor older successional sites may be expected to decline. Active management of beaver populations may be necessary to promote regional vascular plant diversity. Any anthropogenic activities that alter hydrology such as draining or filling wetlands, and diverting or channelizing streams may also have a negative impact on vascular plant diversity in these habitats.

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APPENDIX

ANNOTATED LIST OF THE VASCULAR PLANTS OF BEAVER WETLANDS IN
FRANKLIN AND HAMPSHIRE COUNTIES, MASSACHUSETTS.

Species name is followed by habitat preference (Zone 1 = open water, Zone 2 = mud flats, Zone 3 = wet meadow, Zone 4 = drier meadow, Zone 5 = dry meadow and upland margin, or disturbed areas), abundance (abundant, frequent, occasional, infrequent, or rare; based on criteria described by Palmer et al. 1995), and the number of sites in which it occurred (e.g. 4/15 indicates the species occurred in 4 of the 15 sites). Introduced species are indicated by an asterisk (*). Nomenclature follows Gleason and Cronquist (1991).

LYCOPODIOPHYTA (Clubmosses)

SELAGINELLACEAE

Selaginella apoda (L.) Spring – Zone 3, rare, 1/15

EQUISETOPHYTA (Horsetails)

EQUISETACEAE

Equisetum arvense L. – Zone 5, occasional, 6/15

Equisetum sylvaticum L. – Zones 3,4,5, rare, 4/15

POLYPODIOPHYTA (Ferns)

ASPLENIACEAE

Dryopteris carthusiana (Villars) Fuchs – Zones 4,5, rare, 2/15

Thelypteris noveboracensis (L.) Nieuwl. – Zone 5, rare, 1/15

Thelypteris palustris Schott – Zones 3,4,5, frequent, 14/15

DENNSTAEDTIACEAE

Dennstaedtia punctilobula (Michx.) T. Moore – Zone 4, rare, 1/15

ONOCLEACEAE

Onoclea sensibilis L. – Zones 2,3,4,5, frequent, 15/15

OPHIOGLOSSACEAE

Ophioglossum vulgatum L. var. *pseudopodium* (S. F. Blake) Farw. – Zones 3,4, rare, 1/15

OSMUNDACEAE

Osmunda cinnamomea L. – Zones 3,4,5, rare, 6/15

Osmunda claytoniana L. – Zone 4, rare, 1/15

Osmunda regalis L. – Zones 4,5, occasional, 8/15

PINOPHYTA (Gymnosperms)

CUPRESSACEAE

Juniperus communis L. – Zone 5, disturbed areas, rare, 1/15

PINACEAE

Pinus strobus L. – Zones 4,5, disturbed areas, rare, 5/15

Tsuga canadensis (L.) Carrière – Zones 4,5, disturbed areas, rare, 3/15

MAGNOLIOPHYTA (Flowering Plants)

MAGNOLIOPSIDA (Dicots)

ACERACEAE

Acer pensylvanicum L. – Zone 5, rare, 1/15

Acer rubrum L. – Zones 4,5, occasional, 15/15

Acer spicatum Lam. – Zone 5, rare, 2/15

ANACARDIACEAE

Toxicodendron radicans (L.) Kuntze – Zones 4,5, rare, 2/15

APIACEAE

Cicuta bulbifera L. – Zones 3,4,5, rare, 1/15

**Conium maculatum* L. – Zone 4, disturbed areas, rare, 1/15

Hydrocotyle americana L. – Zones 2,3,4,5, occasional, 11/15

Sium suave Walter – Zones 1,2,5, rare, 4/15

Zizia aurea (L.) Koch – Zone 3, occasional, 1/15

AQUIFOLIACEAE

Ilex verticillata (L.) A. Gray – Zones 4,5, frequent, 11/15

Nemopanthus mucronatus (L.) Loes. – Zone 5, rare, 2/15

ARALIACEAE

Aralia nudicaulis L. – Zone 5, rare, 1/15

ASCLEPIADACEAE

Asclepias incarnata L. – Zone 3, infrequent, 1/15

ASTERACEAE

**Achillea millefolium* L. – Zone 3, disturbed areas, rare, 1/15

- Aster novae-angliae* L. – Zone 4, rare, 1/15
Aster puniceus L. – Zones 3,4, occasional, 11/15
Aster racemosus Elliott – Zones 3,4,5, rare, 3/15
Aster umbellatus Miller – Zone 4, rare, 1/15
Bidens cernua L. – Zones 4,5, frequent, 6/15
Bidens connata Muhl. – Zones 2,5, frequent, 6/15
Bidens frondosa L. – Zone 3, rare, 1/15
**Cirsium arvense* (L.) Scop. – Zone 3, rare, 1/15
Eupatorium maculatum L. – Zones 2,3,4,5, frequent, 12/15
Eupatorium perfoliatum L. – Zones 2,3,4,5, frequent, 14/15
Eupatorium purpureum L. – Zones 2,3,4, infrequent, 3/15
Euthamia graminifolia (L.) Nutt. – Zones 2,4, occasional, 13/15
Senecio aureus L. – Zones 3,4, rare, 3/15
Senecio obovatus Muhl. – Zone 2, rare, 1/15
Solidago caesia L. – Zone 5, rare, 1/15
Solidago canadensis L. – Zones 2,3,4, occasional, 11/15
Solidago patula Muhl. – Zones 3,4,5, infrequent, 3/15
Solidago rugosa Miller – Zones 2,4, occasional, 11/15

BALSAMINACEAE

- Impatiens capensis* Meerb. – Zones 2,3,4,5, frequent, 15/15

BERBERIDACEAE

- **Berberis thunbergii* DC – Zone 3, disturbed areas, rare, 1/15

BETULACEAE

- Alnus incana* (L.) Moench – Zones 2,3,4,5, abundant, 11/15
Alnus serrulata (Aiton) Willd. – Zone 5, rare, 1/15
Betula alleghaniensis Britton – Zones 2,5, occasional, 7/15
Betula lenta L. – Zones 4,5, infrequent, 3/15
Betula papyrifera Marshall – Zone 5, infrequent, 2/15
Betula populifolia Marshall – Zones 4,5, rare, 7/15

BORAGINACEAE

- **Myosotis scorpioides* L. – Zone 4, rare, 1/15

BRASSICACEAE

- Cardamine pensylvanica* Muhl. – Zone 1, rare, 2/15
**Rorippa nasturtium-aquaticum* (L.) Hayek – Zones 2,3, rare, 1/15

CALLITRICHACEAE

- Callitriche palustris* L. – Zone 1, rare, 3/15

CAPRIFOLIACEAE

- **Lonicera* × *bella* Zabel – Zones 4,5, rare, 1/15
Lonicera canadensis Marshall – Zone 4, rare, 1/15
Sambucus canadensis L. – Zones 3,4,5, disturbed areas, rare, 6/15
Viburnum alnifolium Marshall – Zone 5, rare, 1/15
Viburnum dentatum L. var. *lucidum* Aiton – Zones 2,3,4,5, disturbed areas, occasional, 9/15
Viburnum lentago L. – Zone 5, rare, 2/15
Viburnum nudum L. var. *cassinoides* (L.) T. & G. – Zone 5, occasional, 4/15

CLUSIACEAE

- Hypericum canadense* L. – Zones 2,5, occasional, 4/15
Hypericum ellipticum Hook. – Zones 2,3, occasional, 12/15
Hypericum majus (A. Gray) Britton – Zone 4, rare, 1/15
Hypericum mutilum L. – Zones 2,4, infrequent, 12/15
**Hypericum perforatum* L. – Zones 2,3,4, rare, 3/15
Triadenum virginicum (L.) Raf. – Zones 2,3,4,5, frequent, 2/15

CORNACEAE

- Cornus amomum* Miller – Zones 2,3,4, disturbed areas, occasional, 4/15

DROSERACEAE

- Drosera rotundifolia* L. – Zones 4,5, infrequent, 7/15

ERICACEAE

- Lyonia ligustrina* (L.) DC – Zones 3,4,5, infrequent, 2/15
Vaccinium corymbosum L. – Zone 5, occasional, 8/15

FABACEAE

- Amphicarpaea bracteata* (L.) Fern. – Zone 4, rare, 1/15
Apios americana Medikus – Zone 5, rare, 1/15

FAGACEAE

- Fagus grandifolia* Ehrh. – Zone 5, rare, 1/15
Quercus rubra L. – Zone 5, rare, 1/15

GENTIANACEAE

- Gentiana clausa* Raf. – Zones 2,3, infrequent, 1/15

HAMAMELIDACEAE

- Hamamelis virginiana* L. – Zones 4,5, occasional, 2/15

JUGLANDACEAE

Juglans cinerea L. – Zone 5, rare, 1/15

LAMIACEAE

Lycopus americanus Muhl. – Zones 2,4,5, infrequent, 6/15

Lycopus uniflorus Michx. – Zones 2,3,4, occasional, 6/15

Lycopus virginicus L. – Zones 2,4,5, infrequent, 12/15

Mentha arvensis L. – Zone 2, disturbed areas, infrequent, 7/15

Prunella vulgaris L. – Zone 3, rare, 1/15

Scutellaria galericulata L. – Zones 2,3,4, rare, 5/15

Scutellaria lateriflora L. – Zones 3,4,5, rare, 4/15

LAURACEAE

Lindera benzoin (L.) Blume – Zone 5, rare, 1/15

LENTIBULARIACEAE

Utricularia vulgaris L. – Zone 1, occasional, 3/15

MYRICACEAE

Myrica gale L. – Zones 2,3,4,5, occasional, 1/15

NYMPHAEACEAE

Brasenia schreberi J. F. Gmelin – Zone 1, rare, 1/15

Nuphar variegata Durand – Zone 1, infrequent, 1/15

OLEACEAE

Fraxinus americana L. – Zone 5, disturbed areas, rare, 1/15

ONAGRACEAE

Circaea alpina L. – Zones 3,4, rare, 1/15

Epilobium coloratum Biehler – Zones 3,4, rare, 7/15

Epilobium glandulosum Lehm. – Zone 2, occasional, 2/15

Epilobium leptophyllum Raf. – Zone 2, rare, 1/15

Epilobium strictum Muhl. – Zones 3,4,5, infrequent, 7/15

Ludwigia palustris (L.) Elliott – Zone 2, occasional, 15/15

Oenothera fruticosa L. – Zones 4,5, rare, 1/15

OXALIDACEAE

Oxalis acetosella L. – Zones 3,4,5, infrequent, 5/15

Oxalis stricta L. – Zones 3,4,5, rare, 2/15

POLYGONACEAE

Polygonum amphibium L. – Zones 1,2, rare, 1/15

Polygonum arifolium L. – Zones 3,4,5, rare, 4/15

Polygonum hydropiper L. – Zones 2,3, infrequent, 9/15

Polygonum pensylvanicum L. – Zone 1, rare, 2/15

Polygonum sagittatum L. – Zones 2,3,4, disturbed areas, occasional, 13/15

PRIMULACEAE

Lysimachia ciliata L. – Zones 3,4, rare, 1/15

Lysimachia terrestris (L.) BSP. – Zones 2,3,4,5, frequent, 9/15

Trientalis borealis Raf. – Zone 5, rare, 1/15

RANUNCULACEAE

Caltha palustris L. – Zones 2,3,4, occasional, 4/15

Clematis virginiana L. – Zones 3,4,5, occasional, 7/15

Coptis trifolia (L.) Salisb. – Zones 4,5, rare, 2/15

Ranunculus tricophyllus Chaix – Zone 1, occasional, 1/15

Thalictrum pubescens Pursh – Zones 1,3,4, disturbed areas, rare, 5/15

ROSACEAE

Aronia arbutifolia (L.) Elliott – Zones 3,4,5, infrequent, 3/15

Fragaria virginiana F. V. Duchesne – Zone 3, rare, 2/15

Geum laciniatum Murray – Zones 3,4, rare, 2/15

Geum rivale L. – Zones 3,4, rare, 2/15

Potentilla fruticosa L. – Zones 3,4,5, rare, 2/15

**Potentilla norvegica* L. – Zone 4, rare, 1/15

Potentilla palustris (L.) Scop. – Zone 3, rare, 1/15

Potentilla simplex Michx. – Zones 2,3,4,5, rare, 10/15

Prunus serotina Ehrh. – Zones 4,5, infrequent, 7/15

Prunus virginiana L. – Zone 4, rare, 1/15

Rubus hispidus L. – Zones 2,3,4,5, disturbed areas, occasional, 13/15

Rubus idaeus Michx. – Zones 2,3,4,5, occasional, 7/15

Rubus pubescens Raf. – Zone 5, infrequent, 1/15

Rubus setosus Bigelow – Zone 4, rare, 1/15

Spiraea alba DuRoi var. *latifolia* (Aiton) Dippel – Zones 2,3,4,5, disturbed areas, abundant, 15/15

Spiraea tomentosa L. – Zones 2,3,4,5, occasional, 15/15

RUBIACEAE

Cephalanthus occidentalis L. – Zones 4,5, rare, 1/15

Galium asprellum Michx. – Zones 2,3, occasional, 6/15

Galium palustre L. – Zone 2, occasional, 1/15

Galium tinctorium L. – Zones 2,3,4,5, abundant, 14/15

Galium trifidum L. – Zones 2,3,4,5, occasional, 9/15

Galium triflorum Michx. – Zone 5, rare, 1/15

SALICACEAE

Populus balsamifera L. – Zone 3, rare, 1/15

Populus tremuloides Michx. – Zone 5, infrequent, 3/15

Salix bebbiana Sarg. – Zones 3,4,5, rare, 3/15

Salix discolor Muhl. – Zones 2,5, infrequent, 5/15

Salix eriocephala Michx. – Zones 4,5, infrequent, 2/15

Salix lucida Muhl. – Zones 3,4,5, infrequent, 2/15

Salix nigra Marshall – Zone 5, rare, 1/15

Salix sericea Marshall – Zones 3,4,5, occasional, 15/15

SAXIFRAGACEAE

Penthorum sedoides L. – Zone 2, infrequent, 4/15

Saxifraga pensylvanica L. – Zone 4, rare, 1/15

Tiarella cordifolia L. – Zone 2, rare, 1/15

SCROPHULARIACEAE

Chelone glabra L. – Zones 3,4,5, infrequent, 4/15

Mimulus ringens L. – Zones 2,3, infrequent, 11/15

Veronica americana (Raf.) Schwein. – Zones 2,3,4, rare, 2/15

Veronica scutellata L. – Zone 3, rare, 1/15

SOLANACEAE

**Solanum dulcamara* L. – Zones 3,4,5, disturbed areas, rare, 3/15

ULMACEAE

Ulmus rubra Muhl. – Zone 4, rare, 1/15

URTICACEAE

Boehmeria cylindrica (L.) Swartz – Zones 2,3,4, infrequent, 1/15

VERBENACEAE

Verbena hastata L. – Zones 2,3,4, rare, 3/15

VIOLACEAE

Viola cucullata Aiton – Zone 5, rare, 1/15

Viola lanceolata L. – Zones 3,4, rare, 2/15

Viola macloskeyi Lloyd – Zones 2,4,5, infrequent, 14/15

VITACEAE

Parthenocissus quinquefolia (L.) Planchon – Zone 3, rare, 1/15

LILIOPSIDA (Monocots)

ALISMATACEAE

Sagittaria latifolia Willd. – Zones 2,4, occasional, 4/15

ARACEAE

Arisaema triphyllum (L.) Schott – Zone 3, rare, 1/15

CYPERACEAE

- Carex atlantica* L. Bailey – Zones 2,3,4,5, occasional, 11/15
Carex canescens L. – Zones 2,4, infrequent, 2/15
Carex comosa F. Boott – Zones 2,3,4,5, abundant, 8/15
Carex crinita Lam. – Zones 2,4, frequent, 7/15
Carex debilis var. *debilis* Michx. – Zones 3,4, rare, 2/15
Carex eburnea F. Boott – Zones 4,5, rare, 1/15
Carex flava L. – Zones 2,4,5, infrequent, 10/15
Carex intumescens Rudge – Zones 2,3, abundant, 4/15
Carex lacustris Willd. – Zones 3,4, occasional, 3/15
Carex lupulina Muhl. – Zone 3, rare, 1/15
Carex lurida Wahlenb. – Zones 2,3,4, occasional, 14/15
Carex scabrata Schwein. – Zones 3,4, rare, 1/15
Carex scoparia Schkuhr – Zones 2,4, occasional, 11/15
Carex stipata Muhl. – Zones 2,3,4,5, occasional, 5/15
Carex stricta Lam. – Zones 3,4,5, abundant, 13/15
Carex vulpinoidea Michx. – Zones 4,5, occasional, 4/15
Cyperus bipartitus Torr. – Zone 5, rare, 1/15
Cyperus strigosus L. – Zone 3, rare, 1/15
Dulichium arundinaceum (L.) Britton – Zones 3,4,5, abundant, 9/15
Eleocharis acicularis (L.) Roemer & Schultes – Zones 2,3,5, occasional, 8/15
Eleocharis ovata (Roth) Roemer & Schultes – Zone 2, frequent, 13/15
Eleocharis palustris L. – Zones 2,5, occasional, 6/15
Eleocharis tenuis (Willd.) Schultes – Zones 2,4,5, frequent, 12/15
Rhynchospora capitellata (Michx.) Vahl – Zone 1, rare, 3/15
Scirpus atrovirens Willd. – Zones 2,4, occasional, 5/15
Scirpus cyperinus (L.) Kunth – Zones 2,3,4,5, occasional, 15/15
Scirpus microcarpus C. Presl. – Zones 2,4,5, occasional, 9/15
Scirpus polyphyllus Vahl – Zone 1, rare, 2/15
Scirpus smithii A. Gray – Zones 2,3,4, rare, 5/15
Scirpus validus Vahl – Zones 2,4, infrequent, 8/15

ERIOCAULACEAE

Eriocaulon aquaticum (Hill) Druce – Zone 2, rare, 1/15

IRIDACEAE

Iris versicolor L. – Zones 1,2,3,4, rare, 10/15

Sisyrinchium montanum Greene – Zone 1, rare, 1/15

JUNCACEAE

Juncus brachycephalus (Engelm.) Buchenau – Zones 3,4, rare, 2/15

Juncus brevicaudatus (Engelm.) Fern. – Zones 2,4, occasional, 11/15

Juncus canadensis J. Gay – Zone 4, infrequent, 6/15

**Juncus conglomeratus* L. – Zone 4, rare, 1/15

Juncus effusus L. – Zones 2,3,4, occasional, 14/15

Juncus marginatus Rostk. – Zone 1, rare, 1/15

LEMNACEAE

Lemna minor L. – Zone 1, occasional, 6/15

Spirodela polyrhiza (L.) Schleiden – Zone 1, rare, 2/15

LILIACEAE

Lilium canadense L. – Zone 2, rare, 1/15

NAJADACEAE

Najas flexilis (Willd.) Rostkov & Schmidt – Zones 1,2,3, frequent, 2/15

ORCHIDACEAE

Habenaria psycodes (L.) Sprengel var. *psycodes* – Zone 3, rare, 1/15

Liparis loeselii (L.) Rich. – Zones 2,3, rare, 1/15

POACEAE

**Agrostis gigantea* Roth – Zones 2,3,4, frequent, 10/15

Agrostis hyemalis (Walter) BSP. – Zone 3, rare, 1/15

Brachyelytrum erectum (Schreber) P. Beauv. – Zone 3, rare, 1/15

Calamagrostis canadensis (Michx.) P. Beauv. – Zones 2,3, abundant, 10/15

**Echinochloa crusgalli* (L.) P. Beauv. – Zone 5, rare, 1/15

Glyceria canadensis (Michx.) Trin. – Zones 2,3,4,5, occasional, 14/15

Glyceria grandis S. Wats. – Zone 4, rare, 1/15

Glyceria melicaria (Michx.) C. E. Hubbard – Zone 4, rare, 2/15

Glyceria striata (Lam.) A. Hitchc. – Zones 2,3,4, infrequent, 9/15

Leersia oryzoides (L.) Swartz – Zones 2,3,4,5, abundant, 15/15

Muhlenbergia mexicana (L.) Trin. – Zones 2,5, infrequent, 4/15

Panicum lanuginosum Elliott – Zones 3,4, infrequent, 2/15

Panicum rigidulum Nees – Zones 2,3,4, rare, 1/15

Phalaris arundinacea L. – Zones 2,3,4, frequent, 7/15

Phragmites australis (Cav.) Trin. – Zone 3, rare, 1/15

SPARGANIACEAE

Sparganium americanum Nutt. – Zones 1,2,3,4,5, frequent, 7/15

Sparganium androcladum (Engelm.) Morong – Zones 2,3,5, occasional, 9/15

Sparganium chlorocarpum Rydb. – Zones 2,3,5, occasional, 6/15

TYPHACEAE

Typha latifolia L. – Zones 2,3,4,5, abundant, 12/15

ZOSTERACEAE

Potamogeton epihydrus Raf. – Zone 1, rare, 3/15

Potamogeton natans L. – Zone 1, rare, 2/15